PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 06 September 2000 (06.09.00)	
International application No. PCT/US99/25438	**Applicant's or agent's file reference** 50059/007WO2
International filing date (day/month/year) 29 October 1999 (29.10.99)	**Priority date** (day/month/year) 29 October 1998 (29.10.98)
Applicant NADLER, Lee, M. et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

26 May 2000 (26.05.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Olivia TEFY
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
PAUL T. CLARK
CLARK & ELBING LLP
176 FEDERAL STREET
BOSTON, MA 02110-2214

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

	Date of Mailing (*day/month/year*) 04 APR 2000
Applicant's or agent's file reference 50059/007WO2	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/US99/25438	International filing date (*day/month/year*) 29 October 1999 (29.10.1999)
Applicant DANA-FARBER CANCER INSTITUTE	DOCKETED FOR ATTORNEY ATTENTION

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report; however, for more details, see the notes on the accompany sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application , or of the priority claim, must reach the International Bureau as provided in rules 90 *bis* 1 and 90 *bis* 3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Dorthia Lawrence for YVONNE EYLER Telephone No. (703) 308-0196

Form PCT/ISA/220 (July 1998)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 50059/007WO2	FOR FURTHER ACTION	see Notification of Transmittal of International Search Repo (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/US99/25438	International filing date (*day/month/year*) 29 October 1999 (29.10.1999)	(Earliest) Priority Date (*day/month/year*) 29 October 1998 (29.10.1998)

Applicant
DANA-FARBER CANCER INSTITUTE

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the Report**
   a. With regard to the **language**, the international search was carried out on the basis of the international application in t language in which it was filed, unless otherwise indicated under this item.
   ☐ the international search was carried out on the basis of a translation of the international application furnished to th Authority (Rule 23.1(b)).
   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the internatio search was carried out on the basis of the sequence listing:
   ☒ contained in the international application in written form.
   ☐ filed together with the international application in computer readable form.
   ☐ furnished subsequently to this Authority in written form.
   ☐ furnished subsequently to this Authority in computer readable form.
   ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing been furnished.
2. ☐ **Certain claims were found unsearchable** (See Box I).
3. ☐ **Unity of invention is lacking** (See Box II).
4. With regard to the **title**,
   ☐ the text is approved as submitted by the applicant.
   ☒ the text has been established by this Authority to read as follows:
5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applica may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the **drawings** to be published with the abstract is Figure No.
   ☐ as suggested by the applicant. ☒ None of the figures
   ☐ because the applicant failed to suggest a figure.
   ☐ because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/25438

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61K 39/00, 31/70, 39/38; G01N 33/574, 33/48; C12N 5/08; A01N 43/04
US CL : 424/184.1 185.1 277.1; 435/7.23; 472.3; 436/64, 813; 514/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 424/184.1, 185.1, 277.1; 435/7.23, 372.3; 436/64, 813; 514/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WEST, DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BRUNETTE, S. A. et al. Immunotherapy (Cancer): "Tumor Anigen Specific Immunotherapy of Cancer: Peptide and Gene Based Modification of Dendritic Cells as Antigen Presenting Cells." Cancer Biotechnology Weekly. April 1996, page 16,	1-21 and 28-46
Y	CELIS, E. et al. Identification of Potential CTL Epitopes of Tumor-Associated Antigen MAGE-1 for Five Common HLA-A Alleles. Molecular Immunology. 1994, Vol. 31, No. 18, pages 1423-1430, especially page 1423.	22-27
Y	BOHM, C.M. et al. Identification of HLA-A2-Restricted Epitopes of the Tumor-Associated Antigen MUC2 Recognized by Human Cytotoxic T Cells. International J. of Cancer. March 1998, Vol. 75, pages 688-693, especially page 688.	22-27
Y	HERLYN, D. et al. Epitope- and Antigen-Specific Cancer Vaccines. International Review of Immunology. 1991, Vol. 7, pages 245-257, especially page 145.	22-46
Y	US 5,679,647 A (CARSON et al.) 21 October 1997, column 6, line 61 to column 9, line 66.	36-41
Y	US 5,747,317 A (CAO) 05 May 1998, column 3, line 20 to column 5, line 11.	1-21
Y	US 5,770,422 A (COLLINS) 23 June 1998, column 3, line 17 to column 4, line 54.	1-21

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
	04 APR 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer YVONNE EYLER Telephone No. (703) 308-0196

Form PCT/ISA/210 (second sheet) (July 1998)

International application No.
PCT/US99/25438

Continuation of Item 4 of the first sheet: CANCER IMMUNOTHERAPY AND DIAGNOSIS USING UNIVERSAL TUMOR ASSOCIATED ANTIGENS, INCLUDING HTERT.

PTCW

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To: PAUL T. CLARK
CLARK & ELBING LLP
176 FEDERAL STREET
BOSTON, MA 02110-2214

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of Mailing *(day/month/year)*	05 OCT 2000
Applicant's or agent's file reference: 50059/007WO2	REPLY DUE within TWO months from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/25438	29 OCTOBER 1999	29 OCTOBER 1998

International Patent Classification (IPC) or both national classification and IPC
Please See Supplemental Sheet.

Applicant
DANA-FARBER CANCER INSTITUTE

1. This written opinion is the first (first, etc.) drawn by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	[X]	Basis of the opinion
II	[ ]	Priority
III	[ ]	Non-establishment of opinion with regard to novelty, inventive step or industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[ ]	Certain documents cited
VII	[ ]	Certain defects in the international application
VIII	[X]	Certain observations on the international application

3. The applicant is hereby invited to reply to this opinion.

When? See the time limit indicated above. ~~The applicant may, before the expiration of that time limit, request this Authority to grant an extension., see Rule 66.2(d).~~

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3.
For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 *bis*.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 28 FEBRUARY 2001.

Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer GERALD R. EWOLDT
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0196

Form PCT/IPEA/408 (cover sheet) (July 1998)*

WRITTEN OPINION

International application No.
PCT/US99/25438

I. Basis of the opinion

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed

☒ the description:
pages (See Attached) , as originally filed
pages , filed with the demand
pages , filed with the letter of

☒ the claims:
pages (See Attached) , as originally filed
pages , as amended (together with any statement) under Article 19
pages , filed with the demand
pages , filed with the letter of

☒ the drawings:
pages (See Attached) , as originally filed
pages , filed with the demand
pages , filed with the letter of

☒ the sequence listing part of the description:
pages (See Attached) , as originally filed
pages , filed with the demand
pages , filed with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

☒ contained in the international application in printed form.

☒ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the writen sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☒ the description, pages NONE

☒ the claims, Nos. NONE

☒ the drawings, sheets/~~fig~~ NONE

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".*

WRITTEN OPINION

International application No.
PCT/US99/25438

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

Novelty (N)	Claims	1-46	YES
	Claims	NONE	NO
Inventive Step (IS)	Claims	NONE	YES
	Claims	1-46	NO
Industrial Applicability (IA)	Claims	1-46	YES
	Claims	NONE	NO

2. citations and explanations

Claims 1-8, 11-14, 16-17, and 20-46 lack an inventive step under PCT Article 33(3) as being obvious over Cellis et al. (1994) and Bohm et al., (1998) and Brunette et al. (1996) in view of the well known facts disclosed in the background section of the description. The combined Cellis et al.,Bohm et al., and Brunette et al. references teach a method of identifying, isolating, and treating a patient with, a tumor-associated antigen. Said antigens are capable of being presented to T cells by antigen presenting cells (APC) including pre-loaded (antigen pulsed) dendritic cells in a major histocompatibility complex-restricted fashion. The description discloses that hTERT is a well known cancer antigen. Thus it would be obvious to perform the method of the combined references in a method of treating a patient with hTERT or other universal tumor-associated antigen. The T cells, APC, and peptides used in the method would also be obvious. Note that a number of the claims, i.e. claims 2 and 3 concerning autologous versus allogenic T cells and claims 13 and 14 concerning MHC class I and HLA -A2 and HLA-A3, include limitations that comprise optimization of the method and are well within the purview of one of skill in the art.

Claims 9-10 and 36-37 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of U. S. Patent No. 5,679,647. The '647 patent teaches a method of immunizing a patient with naked DNA. Thus it would be obvious to combine the method of immunizing with naked DNA with a method of treating a patient with hTERT or other universal tumor-associated antigen.

Claim 15 lacks an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the preceding paragraphs and further in view of U. S. Patent No. 5,770,422. The '422 patent teaches SEQ ID NOS: 1 and 2. Thus it would be obvious to use the hTERT peptides of SEQ ID NO:1 or 2 in a method of treating a patient with hTERT or other universal tumor-associated antigen.

(Continued on Supplemental Sheet.)

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The description is objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 5 because it fails to adequately enable practice of the claimed invention because: the description is insufficient to support claims for a method of identifying any universal tumor-associated antigens, the antigens so identified, and the nucleic acids encoding said antigens.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

TIME LIMIT:

The time limit set for response to a Written Opinion may not be extended. 37 CFR 1.484(d). Any response received after the expiration of the time limit set in the Written Opinion will not be considered in preparing the International Preliminary Examination Report.

CLASSIFICATION:

The International Patent Classification (IPC) and/or the National classification are as listed below:
IPC(7): A01N 63/00; A61K 39/00; G01N 33/574, 33/53, 33/555, 33/567; C12N 5/08 and US Cl.: 424/93.71, 185.1; 435/7.23, 7.24, 372.2, 372.3

I. BASIS OF OPINION:

This opinion has been drawn on the basis of the description:
page(s) 1-100, as originally filed.
page(s) NONE, filed with the demand.
and additional amendments:
NONE

This opinion has been drawn on the basis of the claims:
page(s) 101-109, as originally filed.
page(s) NONE, as amended under Article 19.
page(s) NONE, filed with the demand.
and additional amendments:
NONE

This opinion has been drawn on the basis of the drawings:
page(s) NONE, as originally filed.
page(s) NONE, filed with the demand.
and additional amendments:
Pages 1-13, filed with the letter of 26 May 2000.

This opinion has been drawn on the basis of the sequence listing part of the description:
page(s) 1-13, as originally filed.
pages(s) NONE, filed with the demand.
and additional amendments:
NONE

V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):

Claims 18 and 19 lack an inventive step under PCT Article 33(3) as being obvious over U.S. Patent No. 5,770,422. The '422 patent teaches the hTERT protein and peptides.

NEW CITATIONS

NONE

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To: PAUL T. CLARK
CLARK & ELBING LLP
176 FEDERAL STREET
BOSTON, MA 02110-2214

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing *(day/month/year)*	23 MAR 2001
Applicant's or agent's file reference: 50059/007WO2	IMPORTANT NOTIFICATION

International application No.	International filing date *(day/month/year)*	Priority Date *(day/month/year)*
PCT/US99/25438	29 OCTOBER 1999	29 OCTOBER 1998

Applicant
DANA-FARBER CANCER INSTITUTE

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	GERALD R. EWOLDT
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0196

Form PCT/IPEA/416 (July 1992)*

PATENT COOPERATION TREATY

PCT

27 MAR 2001

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
50059/007WO2		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/25438	29 OCTOBER 1999	29 OCTOBER 1998
International Patent Classification (IPC) or national classification and IPC Please See Supplemental Sheet.		
Applicant DANA-FARBER CANCER INSTITUTE		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26 MAY 2000	23 FEBRUARY 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer: GERALD R. EWOLDT
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0196

Form PCT/IPEA/409 (cover sheet) (July 1998)★

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US99/25438

I. Basis of the report

1. With regard to the **elements** of the international application:*

[X] the international application as originally filed

[X] the description:
pages 1-100, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

[X] the claims:
pages 101-109, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages NONE, filed with the letter of

[X] the drawings:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

[X] the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

[ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

[ ] the language of publication of the international application (under Rule 48.3(b)).

[ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

[ ] contained in the international application in printed form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readable form.

[ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] The statement that the information recorded in computer readable form is identical to the writen sequence listing has been furnished.

4. [X] The amendments have resulted in the cancellation of:

[X] the description, pages NONE

[X] the claims, Nos. NONE

[X] the drawings, sheets/~~fig~~ NONE

5. [ ] This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US99/25438

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

Novelty (N)	Claims	1-46	YES
	Claims	NONE	NO
Inventive Step (IS)	Claims	NONE	YES
	Claims	1-46	NO
Industrial Applicability (IA)	Claims	1-46	YES
	Claims	NONE	NO

2. citations and explanations (Rule 70.7)

Claims 1-8, 11-14, 16-17, and 20-46 lack an inventive step under PCT Article 33(3) as being obvious over Cellis et al. (1994) and Bohm et al., (1998) and Brunette et al. (1996) in view of the well known facts disclosed in the background section of the description. The combined Cellis et al.,Bohm et al., and Brunette et al. references teach a method of identifying, isolating, and treating a patient with, a tumor-associated antigen. Said antigens are capable of being presented to T cells by antigen presenting cells (APC) including pre-loaded (antigen pulsed) dendritic cells in a major histocompatibility complex-restricted fashion. The description discloses that hTERT is a well known cancer antigen. Thus it would be obvious to perform the method of the combined references in a method of treating a patient with hTERT or other universal tumor-associated antigen. The T cells, APC, and peptides used in the method would also be obvious. Note that a number of the claims, i.e. claims 2 and 3 concerning autologous versus allogenic T cells and claims 13 and 14 concerning MHC class I and HLA -A2 and HLA-A3, include limitations that comprise optimization of the method and are well within the purview of one of skill in the art.

Claims 9-10 and 36-37 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of U. S. Patent No. 5,679,647. The '647 patent teaches a method of immunizing a patient with naked DNA. Thus it would be obvious to combine the method of immunizing with naked DNA with a method of treating a patient with hTERT or other universal tumor-associated antigen.

Claim 15 lacks an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the preceding paragraphs and further in view of U. S. Patent No. 5,770,422. The '422 patent teaches SEQ ID NOS: 1 and 2. Thus it would be obvious to use the hTERT peptides of SEQ ID NO:1 or 2 in a method of treating a patient with hTERT or other universal tumor-associated antigen.

(Continued on Supplemental Sheet.)

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The description is objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 5 because it fails to adequately enable practice of the claimed invention because: the description is insufficient to support claims for a method of identifying any universal tumor-associated antigens, the antigens so identified, and the nucleic acids encoding said antigens.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

CLASSIFICATION:

The International Patent Classification (IPC) and/or the National classification are as listed below:
IPC(7): A01N 63/00; A61K 39/00; G01N 33/574, 33/53, 33/555, 33/567; C12N 5/08 and US Cl.: 424/93.71, 185.1; 435/7.23, 7.24, 372.2, 372.3

V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):

Claims 18 and 19 lack an inventive step under PCT Article 33(3) as being obvious over U.S. Patent No. 5,770,422. The '422 patent teaches the hTERT protein and peptides.

---------- NEW CITATIONS ----------
NONE

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/25438

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61K 39/00, 31/70, 39/38; G01N 33/574, 33/48; C12N 5/08; A01N 43/04
US CL : 424/184.1 185.1 277.1; 435/7.23; 472.3; 436/64, 813; 514/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 424/184.1, 185.1, 277.1; 435/7.23, 372.3; 436/64, 813; 514/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WEST, DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BRUNETTE, S. A. et al. Immunotherapy (Cancer): "Tumor Anigen Specific Immunotherapy of Cancer: Peptide and Gene Based Modification of Dendritic Cells as Antigen Presenting Cells." Cancer Blotechnology Weekly. April 1996, page 16,	1-21 and 28-46
Y	CELIS, E. et al. Identification of Potential CTL Epitopes of Tumor-Associated Antigen MAGE-1 for Five Common HLA-A Alleles. Molecular Immunology. 1994, Vol. 31, No. 18, pages 1423-1430, especially page 1423.	22-27
Y	BOHM, C.M. et al. Identification of HLA-A2-Restricted Epitopes of the Tumor-Associated Antigen MUC2 Recognized by Human Cytotoxic T Cells. International J. of Cancer. March 1998, Vol. 75, pages 688-693, especially page 688.	22-27
Y	HERLYN, D. et al. Epitope- and Antigen-Specific Cancer Vaccines. International Review of Immunology. 1991, Vol. 7, pages 245-257, especially page 145.	22-46
Y	US 5,679,647 A (CARSON et al.) 21 October 1997, column 6, line 61 to column 9, line 66.	36-41
Y	US 5,747,317 A (CAO) 05 May 1998, column 3, line 20 to column 5, line 11.	1-21
Y	US 5,770,422 A (COLLINS) 23 June 1998, column 3, line 17 to column 4, line 54.	1-21

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search	Date of mailing of the international search report
	04 APR 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer YVONNE EYLER Telephone No. (703) 308-0196

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

.nternational application No.

PCT/US99/25438

Continuation of Item 4 of the first sheet: CANCER IMMUNOTHERAPY AND DIAGNOSIS USING UNIVERSAL TUMOR ASSOCIATED ANTIGENS, INCLUDING HTERT.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/17885

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C12N15/54 C12N9/12 C12Q1/68 C12Q1/48 C12N15/11
C12N15/85 A01K67/027 C07K16/40 A61K38/45 A61K31/70
C12N1/21 C12N1/19

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C12N C07K C12Q A61K A01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 01835 A (GERON CORP ;VILLEPONTEAU BRYANT (US); FENG JUNLI (US); FUNK WALTER) 25 January 1996 cited in the application	1,4, 7-10, 12-14, 45-47, 50-55, 89, 102-105, 110,119, 128,129, 134-141
	see page 9, line 31 - page 14, line 29 see page 47, line 15 - page 54, line 9 see page 55, line 22 - page 59, line 3	
Y	see page 60, line 25 - page 67, line 25	1-115, 119-145

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
24 February 1998	16 -07- 1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	ANDRES S.M.

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 93 23572 A (GERON CORP ;UNIV CALIFORNIA SAN FRANCISCO (US)) 25 November 1993 cited in the application see page 14, line 43 - page 32 see page 47, line 32 - page 49, line 32 see page 60, line 33 - page 62 see examples 2,12,13,16,19 see page 85, line 15 - page 89 see claims	1-115, 119-145
X	WO 96 19580 A (COLD SPRING HARBOR LAB ;GREIDER CAROL (US); COLLINS KATHLEEN (US);) 27 June 1996 cited in the application see examples 8,9	1,4,15, 39-44, 119,122, 127, 139-144
A	WO 95 13382 A (GERON CORP ;UNIV TEXAS (US); UNIV CALIFORNIA (US)) 18 May 1995 see page 15 - page 29, line 34 see page 57 - page 61, line 26 see page 73, line 18 - page 76, line 11 see examples 2,7,12,13,16 see examples 19,21 see claims	1-115, 119-145
A	GREIDER, C.: "Telomere length regulation" ANNUAL REVIEW OF BIOCHEMISTRY, vol. 65, 1996, pages 337-365, XP002056801 cited in the application see page 344, line 9 - page 345, line 5 see page 355, line 31 - page 361, line 2	1-115, 119-145
A	AUTEXIER C ET AL: "Reconstitution of human telomerase activity and identification of a minimal functional region of the human telomerase RNA." EMBO JOURNAL, (1996 NOV 1) 15 (21) 5928-35., XP002056802 cited in the application see the whole document	1,4, 6-10,56, 61
A	FENG J ET AL: "The RNA component of human telomerase." SCIENCE, (1995 SEP 1) 269 (5228) 1236-41., XP000645335 cited in the application	

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	NAKAMURA T M ET AL: "Telomerase catalytic subunit homologs from fission yeast and human." SCIENCE, (1997 AUG 15) 277 (5328) 955-9., XP002056803 cited in the application see the whole document ---	1-4, 6-28, 31-33, 119-123, 125,126, 145
P,X	MEYERSON M ET AL: "hEST2, the putative human telomerase catalytic subunit gene, is up-regulated in tumor cells and during immortalization." CELL, (1997 AUG 22) 90 (4) 785-95., XP002056804 cited in the application see the whole document ---	1-4, 6-28, 31-33, 119-123, 125,126, 145
E	WO 98 01542 A (UNIV CALIFORNIA) 15 January 1998 see the whole document -----	1,4, 7-10, 12-15, 20-33,56

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 97/17885

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Remark: Although claim(s)45-47,50-55,88,92-97,101-103,105-109,128-129 and 134 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See annex

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [X] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-115 and 119-145

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-115 and 119-145

A protein preparation of human telomerase reverse transcriptase, nucleic acids encoding it or derived therefrom, transgenic cells and non-human animals comprising these nucleic acids, antibodies against the protein, the use of the protein, polynucleotides, antibodies, cells or animals in methods for detecting modulators of telomerase activity, preparing recombinant telomerase, for use in diagnostic assays or therapeutic treatments, and for increasing the proliferative capacity of a cell.

2. Claims: 116-118

A method for isolating a selected nucleic acid of unknown sequence.

INTERNATIONAL SEARCH REPORT

...information on patent family members

Inter... ...plication No
PCT/US 97/17885

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9601835 A	25-01-96	US 5583016 A	10-12-96
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		EP 0778842 A	18-06-97
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 97/17885

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9513382 A		WO 9513381 A	18-05-95
		US 5629154 A	13-05-97
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		US 5686306 A	11-11-97
		US 5639613 A	17-06-97
		US 5693474 A	02-12-97
WO 9801542 A	15-01-98	AU 3728197 A	02-02-98

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : A61K 38/45, C12N 9 /12, A61K 39 /39, C12N 5 /06 — A1

(11) International Publication Number: **WO 00/02581**

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(21) International Application Number: PCT/NO99/00220

(22) International Filing Date: 30 June 1999 (30.06.99)

(30) Priority Data:
19983141 8 July 1998 (08.07.98) NO

(71) Applicant *(for all designated States except US)*: NORSK HYDRO ASA [NO/NO]; N–0240 Oslo (NO).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: GAUDERNACK, Gustav [NO/NO]; Det Norske Radiumhospital, Ullernch. 70, N–0310 Oslo (NO). ERIKSEN, Jon, Amund [NO/NO]; Bjørntvedt gt. 37, N–3916 Porsgrunn (NO). MØLLER, Mona [NO/NO]; Skrukkerødtoppen 8, N–3925 Porsgrunn (NO). GJERTSEN, Marianne, Klemp [NO/NO]; Det Norske Radiumhospital, Ullernch. 70, N–0310 Oslo (NO). SÆTERDAL, Ingvil [NO/NO]; Det Norske Radiumhospital, Ullernch. 70, N–0310 Oslo (NO). SÆBØE–LARSEN, Stein [NO/NO]; Det Norske Radiumhospital, Ullernch. 70, N–0310 Oslo (NO).

(74) Agent: LILLEGRAVEN, Rita; Norsk Hydro ASA, N–0240 Oslo (NO).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: ANTIGENIC PEPTIDES DERIVED FROM TELOMERASE

(57) Abstract

This invention relates to proteins or peptides which elicit T cell mediated immunity, and to cancer vaccines and compositions for anti–cancer treatment comprising such proteins or peptide fragments. This invention also relates to pharmaceutical compositions comprising the proteins or peptides and methods for generating T lymphocytes capable of recognising and destroying tumour cells in a mammal. More specifically, a telomerase protein or peptide for use in a method of treatment or prophylaxis of cancer is provided. In a preferred embodiment, the method comprises generating a T cell response against telomerase.

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CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
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EE	Estonia	LR	Liberia	SG	Singapore		

ANTIGENIC PEPTIDES DERIVED FROM TELOMERASE

This invention relates to proteins or peptides which elicit T cell mediated immunity, and to cancer vaccines and compositions for anti-cancer treatment comprising such proteins or peptide fragments. This invention also relates to pharmaceutical compositions comprising the proteins or peptides and methods for generating T lymphocytes capable of recognising and destroying tumour cells in a mammal.

Cancer develops through a multistep process involving several mutational events. These mutations result in altered expression/function of genes belonging to two categories: oncogenes and tumour suppressor genes. Oncogenes arise in nature from proto-oncogenes through point mutations or translocations, thereby resulting in a transformed state of the cell harbouring the mutation. All oncogenes code for and function through a protein. Proto-oncogenes are normal genes of the cell which have the potential of becoming oncogenes. In the majority of cases, proto-oncogenes have been shown to be components of signal transduction pathways. Oncogenes act in a dominant fashion. Tumour-suppressor genes on the other hand, act in a recessive fashion, i.e. through loss of function, and contribute to oncogenesis when both alleles encoding the functional protein have been altered to produce non-functional gene products.

The concerted action of a combination of altered oncogenes and tumour-suppressor genes results in cellular transformation and development of a malignant phenotype.

Such cells are however prone to senescence and have a limited life-span. In the majority of cancers, immortalisation of the tumour cells requires the turning on of an enzyme complex called telomerase. In somatic cells the catalytic subunit of this enzyme is normally not expressed. Additional events, such as the action of proteins encoded by a tumour virus or demethylation of silenced promoter sites can result in expression of a functional telomerase complex in tumour cells.

In the field of human cancer immunology, the last two decades have seen intensive efforts to characterise genuine cancer specific antigens. In particular, effort has been devoted to the analysis of antibodies to human tumour antigens. The prior art suggests that such antibodies can be used for diagnostic and therapeutic purposes, for instance in connection with an anti-cancer agent. However, antibodies can only bind to tumour antigens that are exposed on the surface of tumour cells. For this reason, the efforts to produce a cancer treatment based on the immune system of the body has been less successful than expected.

A fundamental feature of the immune system is that it can distinguish self from nonself and does not normally react against self molecules. It has been shown that rejection of tissues or organs grafted from other individuals is an immune response to the foreign antigens on the surface of the grafted cells. The immune response in general consists of a humeral response, mediated by antibodies, and a cellular response. Antibodies are produced and secreted by B lymphocytes, and typically recognise free antigen in native conformation. They can therefore potentially recognise almost any site exposed on the antigen surface. In contrast to antibodies, T cells, which mediate the cellular arm of the immune response, recognise antigens only in the context of MHC molecules, and only after appropriate antigen processing. This antigen processing usually consists of proteolytic

fragmentation of the protein, resulting in peptides that fit into the groove of the MHC molecules. This enables T cells to also recognise peptides derived from intracellular antigens.

T cells can recognise aberrant peptides derived from anywhere in the tumour cell, in the context of MHC molecules on the surface of the tumour cell. The T cells can subsequently be activated to eliminate the tumour cell harbouring the aberrant peptide. In experimental models involving murine tumours it has been shown that point mutations in intracellular "self" proteins may give rise to tumour rejection antigens, consisting of peptides differing in a single amino acid from the normal peptide. The T cells recognising these peptides in the context of the major histocompatibility (MHC) molecules on the surface of the tumour cells are capable of killing the tumour cells and thus rejecting the tumour from the host (Boon et al.,1989, Cell 58, 293-303).

MHC molecules in humans are normally referred to as HLA (human leucocyte associated antigen) molecules. There are two principal classes of HLA molecules, class I and class II. HLA class I molecules are encoded by HLA A, B and C subloci and primarily activate CD8+ cytotoxic T cells. HLA class II molecules, on the other hand, primarily activate CD4+ T cells, and are encoded by the DR, DP and DQ subloci. Every individual normally has six different HLA class I molecules, usually two alleles from each of the three subgroups A, B and C, although in some cases the number of different HLA class I molecules is reduced due to the occurrence of the same HLA allele twice.

The HLA gene products are highly polymorphic. Different individuals express distinct HLA molecules that differ from those found in other individuals. This explains the difficulty of finding HLA matched organ donors in transplantations. The significance of the genetic variation

of the HLA molecules in immunobiology is reflected by their role as immune-response genes. Through their peptide binding capacity, the presence or absence of certain HLA molecules governs the capacity of an individual to respond to specific peptide epitopes. As a consequence, HLA molecules determine resistance or susceptibility to disease.

T cells may inhibit the development and growth of cancer by a variety of mechanisms. Cytotoxic T cells, both HLA class I restricted CD8+ and HLA class II restricted CD4+ may directly kill tumour cells presenting the appropriate tumour antigens. Normally, CD4+ helper T cells are needed for cytotoxic CD8+ T cell responses, but if the peptide antigen is presented by an appropriate APC, cytotoxic CD8+ T cells can be activated directly, which results in a quicker, stronger and more efficient response.

While the peptides that are presented by HLA class II molecules are of varying length (12-25 amino acids), the peptides presented by HLA class I molecules must normally be exactly nine amino acid residues long in order to fit into the class I HLA binding groove. A longer peptide will result in non-binding if it cannot be processed internally by an APC or target cell, such as a cancer cell, before presenting in the class I HLA groove. Only a limited number of deviations from this requirement of nine amino acids have been reported, and in those cases the length of the presented peptide has been either eight or ten amino acid residues long.

Reviews of how MHC binds peptides can be found in Hans-Georg Rammensee, Thomas Friede and Stefan Stevanovic, (1995, Immunogenetics, 41, 178-228) and in Barinaga (1992, *Science* 257, 880-881). Male et al (1987, *Advanced Immunology*, J.B. Lippincott Company, Philadelphia) offers a more comprehensive explanation of the technical background to this invention.

In our International Application PCT/N092/00032 (published as WO92/14756), we described synthetic peptides and fragments of oncogene protein products which have a point of mutation or translocations as compared to their proto-oncogene or tumour suppressor gene protein. These peptides correspond to, completely cover or are fragments of the processed oncogene protein fragment or tumour suppressor gene fragment as presented by cancer cells or other antigen presenting cells, and are presented as a HLA-peptide complex by at least one allele in every individual. These peptides were also shown to induce specific T cell responses to the actual oncogene protein fragment produced by the cell by processing and presented in the HLA molecule. In particular, we described peptides derived from the p21-*ras* protein which had point mutations at particular amino acid positions, namely positions 12, 13 and 61. These peptides have been shown to be effective in regulating the growth of cancer cells *in vitro*. Furthermore, the peptides were shown to elicit CD4+ T cell immunity against cancer cells harbouring the mutated p21-*ras* oncogene protein through the administration of such peptides in vaccination or cancer therapy schemes. Later we have shown that these peptides also elicit CD8+ T cell immunity against cancer cells harbouring the mutated p21 *ras* oncogene protein through the administration mentioned above (see M.K. Gjertsen et al., Int. J cancer, 1997, vol. 72 p. 784).

However, the peptides described above will be useful only in certain numbers of cancers, namely those which involve oncogenes with point mutations or translocation in a proto-oncogene or tumour suppressor gene. There is therefore a strong need for an anticancer treatment or vaccine which will be effective against a more general range of cancers.

In general, tumours are very heterogeneous with respect to genetic alterations found in the tumour cells. This implies that both the potential therapeutic effect and prophylactic

strength of a cancer vaccine will increase with the number of targets that the vaccine is able to elicit T cell immunity against. A multiple target vaccine will also reduce the risk of new tumour formation by treatment escape variants from the primary tumour.

The enzyme telomerase has recently been the focus of attention for its supposed role in prevention of cellular ageing. Telomerase is a RNA-dependent DNA polymerase, which synthesises telomeric DNA repeats using an RNA template that exists as a subunit of the telomerase holoenzyme. The DNA repeats synthesised by the enzyme are incorporated into telomeres, which are specialised DNA-protein structures found at the ends of the linear DNA molecules which make up every chromosome. Telomerase was first identified in the ciliate *Tetrahymena* (Greider and Blackburn, 1985, *Cell* 43, 405-413). A human telomerase catalytic subunit sequence was recently identified by Meyerson et al (1990, *Cell* 1197 , 785-795), and Nakamura et al (1997, *Science* 277, 955-959), who respectively named the gene hEST2 and hTRT. In addition, three other proteins which are associated with telomerase activity have also been identified: p80 and p95 of *Tetrahymena* (Collins et al, 1995, *Cell* 81, 677-686) and TP1/TLP1, which is the mammalian homologue of *Tetrahymena* p80 (Harrington et al, 1997, *Science*, 275, 973-977; Nakayama et al., 1997, *Cell* 88, 875-884).

Telomerase is not expressed in most normal cells in the body. Most somatic lineages in humans show no detectable telomerase activity, but telomerase activity is detected the germline and in some stem cell compartments, which are sites of active cell division (Harley et al., 1994, *Cold Spring Harbor Symp. Quant. Biol.* 59, 307-315; Kim et al., 1994, *Science* 266, 2011-2015; Broccoli et al, 1995, *PNAS USA* 92, 9082-9086; Counter et al., 1995, *Blood* 85, 2315-2320; Hiyama et al., 1995, *J. Immunol.* 155, 3711-3715). Telomeres of most types of

human somatic cells shorten with increasing age of the organism, consistent with lack of telomerase activity in these cells. Cultured human cells also show telomere shortening. Telomere shortening continues in cultured human cells which have been transformed, until the telomeres have become critically short. At this point, termed the crisis point, significant levels of cell death and karyotypic instability are observed.

Immortal cells, which have acquired the ability to grow indefinitely in culture, emerge at rare frequency from crisis populations. These immortal cells have high levels of telomerase activity and stable telomeres. Telomerase activity is also readily detected in the great majority of human tumour samples analysed to date (Kim et al, 1994, *Science* 266, 2011-2015), including ovarian carcinoma (Counter et al., 1994, *PNAS USA* 91, 2900-2904). A comprehensive review is provided by Shay and Bachetti (1997, *Eur. J. Cancer* 33, 787-791). Thus, activation of telomerase may overcome the barriers to continuous cell division imposed by telomere length. Cells that overcome the normal senescence mechanisms may do so by stabilising telomere length, probably due to the activity of telomerase.

Viruses implicated in human cancer development such as Epstein Barr virus (EBV, related to B cell malignancies and nasopharyngeal carcinomas) and Human Papilloma virus (HPV 16 and 18, related to cervical carcinomas) have long been known to have the capacity to immortalize human cells. It has now been demonstrated that induction of telomerase activity is the key element in this process (Klingelhutz et al, 1996, *Nature*, 380, 79-82).

Telomerase is therefore a potential target for cancer therapy. Thus, telomerase inhibitors have been proposed as a new class of anti-cancer drugs (reviewed in Sharma et al,

1997, *Ann Oncol* 8(11), 1063-1074; Axelrod, 1996, *Nature Med* 2(2), 158-159; Huminiecki, 1996, *Acta Biochim Pol*, 43(3), 531-538). It has been suggested that the identification of a human telomerase catalytic subunit may provide a biochemical reagent for identifying such drugs (Meyerson et al, 1990, *Cell* 1197, 785-795). Telomerase has also been suggested to be a marker for diagnosis or prognosis of cancer (Soria and Rixe, 1997, *Bull Cancer* 84(10), 963-970; Dahse et al, 1997, *Clin Chem* 43(5), 708-714).

As far as we are aware, however, no one has previously suggested that telomerase may function as a useful target for T cell mediated therapy, or that telomerase peptides or proteins may be used for the treatment or prophylaxis of cancer.

In accordance with one aspect of the invention, we provide a telomerase protein or peptide for use in a method of treatment or prophylaxis of cancer.

In accordance with a second aspect of the invention, there is provided a nucleic acid for use in a method of treatment or prophylaxis of cancer, the nucleic acid being capable of encoding a telomerase protein or peptide as provided in the first aspect of this invention.

We provide, in accordance with a third aspect of this invention a pharmaceutical composition comprising at least one telomerase protein or peptide or nucleic acid as provided in the first or second aspect of this invention and a pharmaceutically acceptable carrier or diluent.

According to a fourth aspect of this invention, we provide a method for the preparation of a pharmaceutical composition as provided in the third aspect of the invention, the method comprising mixing at least one telomerase protein or peptide

or nucleic acid as provided in the first or second aspect of the invention with a pharmaceutically acceptable carrier or diluent.

There is further provided, according to a fifth aspect of this invention a pharmaceutical composition comprising a combination of at least one telomerase protein or peptide as provided in the first aspect of this invention and at least one peptide capable of inducing a T cell response against an oncogene or mutant tumour suppressor protein or peptide, together with a pharmaceutically acceptable carrier or diluent.

We further provide, in accordance with a sixth aspect of this invention, a method for the preparation of a pharmaceutical composition as provided in the fifth aspect of this invention, the method comprising mixing at least one telomerase protein or peptide provided in the first aspect of this invention, with at least one peptide capable of inducing a T cell response against an oncogene or tumour suppressor protein or peptide, and a pharmaceutically acceptable carrier or diluent.

In accordance with a seventh aspect of this invention, we provide the use, in the preparation of a medicament for the treatment or prophylaxis of cancer, of a telomerase protein or peptide, or a nucleic acid capable of encoding a telomerase protein or peptide.

According to a eighth aspect of this invention, there is provided a method of generating T lymphocytes capable of recognising and destroying tumour cells in a mammal, comprising taking a sample of T lymphocytes from a mammal, and culturing the T lymphocyte sample in the presence of telomerase protein or peptide in an amount sufficient to generate telomerase protein or peptide specific T lymphocytes.

The invention is more particularly described, by way of example only, with reference to the accompanying drawing, in which:

FIGURE 1 shows the sequences of the conserved amino acid motifs in the human telomerase catalytic subunit, as identified by Meyerson et al (1997, Cell 90, 785-795) and Nakamura et al (1997 *Science* 277, 955-959). Motifs T, 1, 2, 3 (A of Nakamura), 4 (B'of Nakamura) 5 (C of Nakamura), 6 (D of Nakamura) and E are shown. Peptides may be synthesised with sequences corresponding to or encompassing any of the bracketed regions. The designations A2, A1, A3 and B7 indicate peptides which are likely to be presented by HLA-A2, HLA-A1, HLA-A3 and HLA-B7 respectively.

We provide a telomerase protein or peptide for use in a method of treatment or prophylaxis of cancer. In a preferred embodiment, the method comprises generating a T cell response against telomerase. The method may comprise administering to a mammal, preferably a human, suffering or likely to suffer from cancer a therapeutically effective amount of the telomerase protein or peptide so that a T cell response against the telomerase is induced in the mammal.

Telomerase specific T cells may be used to target cells which express telomerase. Thus, since most cells in the body of an organism do not express telomerase, they will be unaffected. However, tumour cells that express telomerase will be targeted and destroyed. As telomerase activity has been detected in the majority of cancers identified so far, we expect our materials and methods to have widespread utility.

Cancers which are suitable for treatment include, but are not limited to, breast cancer, prostate cancer, pancreatic cancer, colo-rectal cancer, lung cancer, malignant melanoma,

leukaemias, lymphomas, ovarian cancer, cervical cancer and biliary tract carcinomas.

As used here, the term telomerase denotes a ribonucleoprotein enzyme which has telomere elongating activity. Telomerase protein as used here denotes any protein component of telomerase, including any subunit having catalytic activity.

Preferably the telomerase protein is a mammalian telomerase protein, and most preferably a human telomerase protein. The human telomerase protein is preferably the telomerase catalytic subunit identified as hTRT by Nakamura et al (1997, *Science* 277, 955-959) and hEST2 by Meyerson et al (1990, *Cell* 1197 , 785-795), the cDNA sequences of which are deposited as GenBank accession numbers AF015950 and AFO18167 respectively.

The term telomerase peptide as used here means a peptide which has an amino acid sequence corresponding to a sequence present in the amino acid sequence of a telomerase protein. The telomerase peptides preferably contain between 8 and 25 amino acids. More preferably, the telomerase peptides contain between 9 and 25 amino acids. For instance, the telomerase peptides contain 9, 12, 13, 16 or 21 amino acids.

The telomerase protein or peptide is chosen so that it is capable of generating a T cell response directed against the telomerase protein (or against the telomerase protein from which the telomerase peptide is derived). In preferred embodiments, the T cell response induced is a cytotoxic T cell response. The cytotoxic T cell response may be a CD4+ T cell response, or it may be a CD8+ T cell response. In any case, the peptide must be capable of being presented as a complex with a MHC class I or class II protein on the surface of tumour cells or antigen presenting cells, with antigen processing taking place beforehand if necessary.

The telomerase peptide may include one or more amino acid residues from an amino acid motif essential for the biological function of the telomerase protein; in other words, it may overlap at least partially with such an amino acid motif. Examples of such amino acid motifs are motifs 1 to 6 of the human telomerase catalytic subunit sequence hEST2 as identified by Meyerson et al (1990, *Cell* 1197, 785-795), in other words, from the motifs

LLRSFFYVTE
SRLRFIPK,
LRPIVNMDYVVG,
PELYFVKVDVTGAYDTI,
KSYVQCQGIPQGSILSTLLCSLCY,
LLLRLVDDFLLVT and
GCVVNLRKTVV

or from any of motifs T, 1, 2, A, B', C, D or E as identified by Nakamura et al (1997, *Science* 277, 955-959) in the hTRT sequence, namely, the motifs

WLMSVYVVELLRSFFYVTETTFQKNRLFFYRKSVWSKLQSIGIRQHLK,
EVRQHREARPALLTSRLRFIPKPDG,
LRPIVNMDYVVGARTFRREKRAERLTSRV,
PPPELYFVKVDVTGAYDTIPQDRLTEVIASIIKP,
KSYVQCQGIPQGSILSTLLCSLCYGDMENKLFAGI,
LLRLVDDFLLVTPHLTH,
AKTFLRTLVRGVPEYGCVVNLRKTVV and HGLFPWCGLLL.

Suitable peptides which may be used in the methods and compositions described here are set out in TABLE 1 as well as in the attached sequence identity list.

Another set of suitable peptides derived from elsewhere in the telomerase sequence, which may be used in the methods and compositions described here, are set out in TABLE 2.

Also included are proteins and peptides having amino acid sequences corresponding to an amino acid sequence present in

the amino acid sequence of mammalian homologues of the *Tetrahymena* telomerase associated proteins p80 and p95. For example, the p80 homologues TP1 and TLP1 (Harrington et al, 1997, *Science*, 275, 973-977; Nakayama et al., 1997, *Cell* 88, 875-884).

Larger peptide fragments carrying a few amino acid substitutions at either the N-terminal end or the C-terminal end are also included, as it has been established that such peptides may give rise to T cell clones having the appropriate specificity.

The peptides described here are particularly suited for use in a vaccine capable of safely eliciting either CD4+ or CD8+ T cell immunity:

a) the peptides are synthetically produced and therefore do not include transforming cancer genes or other sites or materials which might produce deleterious effects,

(b) the peptides may be used alone to induce cellular immunity,

(c) the peptides may be targeted for a particular type of T cell response without the side effects of other unwanted responses.

The telomerase peptides or proteins described here can be administered in an amount in the range of 1 microgram (1µg) to 1 gram (1g) to an average human patient or individual to be vaccinated. It is preferred to use a smaller dose in the range of 1 microgram (1µg) to 1 milligram (1mg) for each administration.

In preferred embodiments, the telomerase protein or peptide is provided to the patient in the form of a pharmaceutical composition. The telomerase protein or peptide may be administered as a mixture of proteins or a mixture of proteins and peptides or a mixture of peptides. The

pharmaceutical composition may in addition include the usual additives, diluents, stabilisers or the like as known in the art.

The pharmaceutical composition may comprise one or more telomerase proteins or peptides. The protein or peptide mixture may be any one of the following:

(a) a mixture of peptides having different sequences, for example, corresponding to different portions of a telomerase protein sequence;

(b) a mixture of peptides having overlapping sequences, but suitable to fit different HLA alleles;

(c) a mixture of both mixtures (a) and (b);

(d) a mixture of several mixtures (a);

(e) a mixture of several mixtures (b);

(f) a mixture of several mixtures (a) and several mixtures (b);

In each case, a mixture of proteins or peptides corresponding to different telomerase proteins, for example, a telomerase catalytic subunit and a *Tetrahymena* p80 or p95 homologue, may also be used.

Alternatively, the telomerase peptides in the mixture may be covalently linked with each other to form larger polypeptides or even cyclic polypeptides. The pharmaceutical composition may be made by mixing the telomerase protein(s) or peptide(s) with a pharmaceutically acceptable carrier or diluent.

The pharmaceutical composition may also include at least one peptide capable of inducing a T cell response against an oncogene or mutant tumour suppressor protein or peptide. Alternatively, the telomerase proteins or peptides may be administered either simultaneously or in optional sequence with these peptides. Examples of oncogene proteins are the p21-*ras* proteins H-ras, K-ras and N-ras, abl, gip, gsp, ret

and trk. Preferably, the oncogene protein or peptide is a p21-*ras* protein or peptide, for example, the p21-*ras* peptides described in our International Application PCT/NO92/00032 (publication number WO92/14756). Tumour suppressor proteins include p53 and Rb (retinoblastoma). Such a pharmaceutical composition may be made by mixing the telomerase protein(s) or peptide(s) with the mutant tumour suppressor or oncogene proteins or peptides, together with a pharmaceutically acceptable carrier or diluent.

As used here, the term mutant refers to a wild type sequence which has one or more of the following: point mutation (transition or transversion), deletion, insertion, duplication translocation or inversion. The term pharmaceutical composition not only encompasses a composition usable in treatment of cancer patients, but also includes compositions useful in connection with prophylaxis, i.e., vaccine compositions.

The telomerase peptides or proteins are administered to a human individual in need of such treatment or prophylaxis. The administration may take place one or several times as suitable to establish and/or maintain the wanted T cell immunity. The peptides may be administered together, either simultaneously or separately, with compounds such as cytokines and/or growth factors, i.e., interleukin-2 (IL-2), interleukin-12 (IL-12), granulocyte macrophage colony stimulating factor (GM-CSF) or the like in order to strengthen the immune response as known in the art. The telomerase proteins or peptides can be used in a vaccine or a therapeutical composition either alone or in combination with other materials. For example, the peptide or peptides may be supplied in the form of a lipopeptide conjugate which is known to induce a high-affinity cytotoxic T cell response (Deres, 1989, *Nature* 342).

The peptides and proteins mentioned above as possible constituents of the pharmaceutical composition may be provided in the form of nucleic acid encoding the particular peptide or protein. Thus, the pharmaceutical composition may consist of peptide and/or protein alone, or in combination with nucleic acid, or it may consist of mixtures of nucleic acids.

The telomerase peptides or proteins may be administered to an individual in the form of DNA vaccines. The DNA encoding the telomerase peptide or protein may be in the form of cloned plasmid DNA or synthetic oligonucleotide. The DNA may be delivered together with cytokines, such as IL-2, and/or other co-stimulatory molecules. The cytokines and/or co-stimulatory molecules may themselves be delivered in the form of plasmid or oligonucleotide DNA.

The response to a DNA vaccine has been shown to be increased by the presence of immunostimulatory DNA sequences (ISS). These can take the form of hexameric motifs containing methylated CpG, according to the formula : 5'-purine-purine-CG-pyrimidine-pyrimidine-3'. Our DNA vaccines may therefore incorporate these or other ISS, in the DNA encoding the telomerase peptide or protein, in the DNA encoding the cytokine or other co-stimulatory molecules, or in both. A review of the advantages of DNA vaccination is provided by Tighe et al (1998, *Immunology Today*, 19(2), 89-97).

We describe a method of treatment of a patient afflicted with cancer, the method comprising eliciting T-cell responses through stimulating *in vivo* or *ex vivo* with a telomerase protein or peptide. The telomerase protein or peptide can also be used in a method of vaccination of a patient in order to obtain resistance against cancer. A suitable method of vaccination comprises eliciting T-cell responses through

stimulating *in vivo* or *ex vivo* with a telomerase protein or peptide. We also describe a method of treatment or prophylaxis of cancer, comprising administering to a mammal suffering or likely to suffer from cancer a therapeutically effective amount of a telomerase protein or peptide so that a T cell response against telomerase is induced in the mammal.

The peptides described here may be produced by conventional processes, for example, by the various peptide synthesis methods known in the art. Alternatively, they may be fragments of a telomerase protein produced by cleavage, for example, using cyanogen bromide, and subsequent purification. Enzymatic cleavage may also be used. The telomerase proteins or peptides may also be in the form of recombinant expressed proteins or peptides.

Nucleic acids encoding the telomerase peptide can be made by oligonucleotide synthesis. This may be done by any of the various methods available in the art. A nucleic acid encoding telomerase protein may be cloned from a genomic or cDNA library, using conventional library screening. The probe may correspond to a portion of any sequence of a known telomerase gene. Alternatively, the nucleic acid can be obtained by using the Polymerase Chain Reaction (PCR). The nucleic acid is preferably DNA, and may suitably be cloned into a vector. Subclones may be generated by using suitable restriction enzymes. The cloned or subcloned DNA may be propagated in a suitable host, for example a bacterial host. Alternatively, the host can be a eukaryotic organism, such as yeast or baculovirus. The telomerase protein or peptides may be produced by expression in a suitable host. In this case, the DNA is cloned into an expression vector. A variety of commercial expression kits are available. The methods described in Maniatis et al (1991, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor, New York, Cold Spring Harbor Laboratory Press) and Harlow and Lane (1988,

Antibodies: A Laboratory Manual, Cold Spring Harbor, New York, Cold Spring Harbor Laboratory Press) may be used for these purposes.

Experimental Methods

The peptides were synthesised by using continuous flow solid phase peptide synthesis. N-a-Fmoc-amino acids with appropriate side chain protection were used. The Fmoc-amino acids were activated for coupling as pentafluorophenyl esters or by using either TBTU or diisopropyl carbodiimide activation prior to coupling. 20% piperidine in DMF was used for selective removal of Fmoc after each coupling. Cleavage from the resin and final removal of side chain protection was performed by 95% TFA containing appropriate scavengers. The peptides were purified and analysed by reversed phase (C18) HPLC. The identify of the peptides was confirmed by using electro-spray mass spectroscopy (Finnigan mat SSQ710).

In order for a cancer vaccine and methods for specific cancer therapy based on T cell immunity to be effective, three conditions must be met:

(a) the peptide is at least 8 amino acids long and is a fragment of a telomerase protein and

(b) the peptide is capable of inducing, either in its full length or after processing by antigen presenting cell, T cell responses.

The following experimental methods may be used to determine if these three conditions are met for a particular peptide. First, it should be determined if the particular peptide gives rise to T cell immune responses *in vitro*. It will also need to be established if the synthetic peptides correspond to, or are capable after processing to yield, peptide fragments corresponding to peptide fragments occurring in

cancer cells harbouring telomerase or antigen presenting cells that have processed naturally occurring telomerase. The specificity of T cells induced *in vivo* by telomerase peptide vaccination may also be determined.

It is necessary to determine if telomerase expressing tumour cell lines can be killed by T cell clones obtained from peripheral blood from carcinoma patients after telomerase peptide vaccination. T cell clones are obtained after cloning of T-cell blasts present in peripheral blood mononuclear cells (PBMC) from a carcinoma patient after telomerase peptide vaccination. The peptide vaccination protocol includes several *in vivo* injections of peptides intracutaneously with GM-CSF or another commonly used adjuvant. Cloning of T cells is performed by plating responding T cell blasts at 5 blasts per well onto Terasaki plates. Each well contains 2 x 10^4 autologous, irradiated (30 Gy) PBMC as feeder cells. The cells are propagated with the candidate telomerase peptide at 25 mM and 5 U/ml recombinant interleukin-2 (rIL-2) (Amersham, Aylesbury, UK) in a total volume of 20 mL. After 9 days T cell clones are transferred onto flat-bottomed 96-well plates (Costar, Cambridge, MA) with 1 mg/ml phytohemagglutinin (PHA, Wellcome, Dartford, UK), 5 U/ml rIL-2 and allogenic irradiated (30 Gy) PBMC (2 x 10^5) per well as feeder cells. Growing clones are further expanded in 24-well plates with PHA / rIL-2 and 1 x 10^6 allogenic, irradiated PBMC as feeder cells and screened for peptide specificity after 4 to 7 days.

T cell clones are selected for further characterisation. The cell-surface phenotype of the T cell clone is determined to ascertain if the T cell clone is CD4+ or CD8+. T cell clone is incubated with autologous tumour cell targets at different effector to target ratios to determine if lysis of tumour cells occurs. Lysis indicates that the T cell has reactivity

directed against a tumour derived antigen, for example, telomerase protein.

In order to verify that the antigen recognised is associated with telomerase protein, and to identify the HLA class I or class II molecule presenting the putative telomerase peptide to the T cell clone, different telomerase expressing tumour cell lines carrying one or more HLA class I or II molecules in common with those of the patient are used as target cells in cytotoxicity assays. Target cells are labelled with ^{51}Cr or ^{3}H-thymidine (9.25×10^{4} Bq/mL) overnight, washed once and plated at 5000 cells per well in 96 well plates. T cells are added at different effector to target ratios and the plates are incubated for 4 hours at 37°C and then harvested before counting in a liquid scintillation counter (Packard Topcount). For example, the bladder carcinoma cell line T24 ($12Val^{+}$, $HLA\text{-}A1^{+}$, $B35^{+}$), the melanoma cell line FMEX ($12Val^{+}$, $HLA\text{-}A2^{+}$, $B35^{+}$) and the colon carcinoma cell line SW 480 ($12Val^{+}$, $HLA\text{-}A2^{+}$, $B8^{+}$) or any other telomerase positive tumour cell line may be used as target cells. A suitable cell line which does not express telomerase protein may be used as a control, and should not be lysed. Lysis of a particular cell line indicates that the T cell clone being tested recognises an endogenously-processed telomerase epitope in the context of the HLA class I or class II subtype expressed by that cell line.

The HLA class I or class II restriction of a T cell clone may be determined by blocking experiments. Monoclonal antibodies against HLA class I antigens, for example the panreactive HLA class I monoclonal antibody W6/32, or against class II antigens, for example, monoclonals directed against HLA class II DR, DQ and DP antigens (B8/11, SPV-L3 and B7/21), may be used. The T cell clone activity against the autologous tumour cell line is evaluated using monoclonal antibodies directed against HLA class I and class II molecules at a final concentration of 10 mg/ml. Assays are set up as described

above in triplicate in 96 well plates and the target cells are preincubated for 30 minutes at 37°C before addition of T cells.

The fine specificity of a T cell clone may be determined using peptide pulsing experiments. To identify the telomerase peptide actually being recognised by a T cell clone, a panel of nonamer peptides is tested. ^{51}Cr or ^{3}H-thymidine labelled, mild acid eluted autologous fibroblasts are plated at 2500 cells per well in 96 well plates and pulsed with the peptides at a concentration of 1 mM together with b2-microglobulin (2.5 mg/mL) in a 5% CO_2 incubator at 37°C before addition of the T cells. Assays are set up in triplicate in 96 well plates and incubated for 4 hours with an effector to target ratio of 5 to 1. Controls can include T cell clone cultured alone, with APC in the absence of peptides or with an irrelevant melanoma associated peptide MART-1/Melan-A peptide.

An alternative protocol to determine the fine specificity of a T cell clone may also be used. In this alternative protocol, the TAP deficient T2 cell line is used as antigen presenting cells. This cell line expresses only small amounts of HLA-A2 antigen, but increased levels of HLA class I antigens at the cell surface can be induced by addition of b2-microglobulin. ^{3}H-labelled target cells are incubated with the different test peptides and control peptides at a concentration of 1 mM together with b2-microglobulin (2.5 mg/mL) for one hour at 37°C. After peptide pulsing, the target cells are washed extensively, counted and plated at 2500 cells per well in 96 well plates before addition of the T cells. The plates are incubated for 4 hours at 37°C in 5% CO_2 before harvesting. Controls include T cell clone cultured alone or with target cells in the absence of peptides. Assays were set up in triplicate in 96 well plates with an effector to target ratio of 20 to 1.

The sensitivity of a T cell clone to a particular peptide identified above may also be determined using a dose-response experiment. Peptide sensitised fibroblasts can be used as target cells. The target cells are pulsed with the particular peptide as described above for fine specificity determination, with the exception that the peptides are added at different concentrations before the addition of T cells. Controls include target cells alone and target cells pulsed with the irrelevant melanoma associated peptide Melan-A/Mart-1.

Biological experiments/ Description of the figures:

Figure 1

Figure 1 (Fig. 1) describes the induction of telomerase (hTERT) reactive cytotoxic T lymphocytes (CTL's) in HLA-A2(A2/K^b) transgenic mice immunized with telomerase peptides with sequence identity 9 and 10. A standard HLA-A2 restricted influenza (58-66) peptide was used as control. Three groups of five mice each were given two weekly subcutaneous injections of 10^7 irradiated, peptide pulsed (100 µg/ml) syngeneic spleen cells. One week after the second injection, the mice were sacrificed and their spleens harvested. Spleen cells were prepared by standard techniques, and cells from primed animals were restimulated in vitro for 5 days by coculture with peptide pulsed (10 µg/ml) irradiated auatologous spleen cells as antigen presenting cells before testing of cytotoxicity against hTERT expressing target cells (Jurkat) transfected with HLA-A2 (A2/K^b) in a ^{51}Cr release assay.

Columns to the left of Fig. 1 show killing of HLA-A2 transfected Jurkat cells pulsed with the control peptide (influenza 58-66) by T cells obtained after priming of mice

with the peptide with sequence identity 9, at different effector to target ratios. Specific cytotoxicity above background was observed at all effector to target ratios. Columns in the middle show similar data with T cells obtained from mice primed with the peptide with sequence identity 10. Significant killing of Jurkat cells was only observed when spleen cells from telomerase peptide pulsed mice were used as effector cells, thus when spleen cells from influenza peptide primed mice were used as effectors, only background level of killing of Jurkat cells was seen when the target cells were pulsed with an irrelevant peptide (melanocortin receptor 1 peptide, MC1R244) as evident from columns in the right part of Fig. 1. These results demonstrate that the peptides with sequence identity 9 and 10 are immunogenic in vivo and upon immunization may elicit an immune response in a warm blooded animal carrying the common human MHC molecule HLA-A2. This finding indicates that the peptides with seq. id. no. 9 and 10 may also be used as a cancer vaccine in humans carrying HLA-A2 and other HLA class I molecules capable of binding these peptides. Furthermore, these results demonstrate that hTERT expressed by the T cell leukemia line Jurkat can be processed by the proteolytic machinery of the cell line to yield peptide fragments identical with or similar to the peptides with sequence identity 9 and 10. Together these observations indicate that an immune response obtained after vaccination of cancer patients or patients at risk of developing cancer with these peptides may result in efficient killing of tumor cells expressing the hTERT subunit of telomerase.

Fig. 1 depicts cytotoxicity of HLA-A2 transfected Jurkat cells with effector cells obtained from mice immunized as indicated in the figure. Target cells were labeled with ^{51}Cr (0,1 µCi/100 µl cell suspension) for 1 hr. at 37 °C, washed twice and pulsed with peptide (1 µg/ml) for 1 hr at 37 °C before washing. Two thousand labeled, peptide pulsed target

cells were seeded per well in a 96 well v-bottom microtitre plate, and effector cells (from $2,5x10^4$ to $2x10^5$) were added to the wells. Cultures were incubated for 4 hrs. at 37 °C and supernatants were harvested and tested in a gamma-counter. The results in Fig. 1 are expressed as specific cytotoxicity calculated by the following formula:

(cpm experimental released - cpm spontaneously released)/
(cpm total - cpm spontaneously released) x 100

Figure 2

Figure 2 (Fig. 2) shows the results of in vitro stimulation of peripheral blood T cells from a patient (TT) with colon cancer with telomerase (hTERT) derived peptides with sequence identity number 2, 3, 4 and 7. In vitro culture was performed as follows: Triplicates of 10^5 mononuclear cells were incubated for 6 days in X-VIVO 10 medium supplemented with 15% pooled heat inactivated human serum in a humidified incubator in 5% CO_2. Peptides were present throughout culture at a final concentration of 30 µg/ml in the medium. Cultures without peptide served as control. A proliferative response above background values was seen when the T cells were stimulated with the peptide with sequence identity 4. These results demonstrate that blood from a cancer patient contains circulating T cells specific for a peptide derived from telomerase (hTERT). These results demonstrate that the enzymatic subunit of telomerase (hTERT) is immunogenic in man, and may spontaneously give rise to telomerase specific T cell responses when overexpressed by a tumor growing in the patient. Furthermore, one component of the telomerase specific response in this patient is directed against the peptide with seq. id. no. 4 described here. This finding indicates that the peptide with seq. id. no. 4 may also be used as a cancer vaccine in humans. The figure depicts the

results of conventional T cell proliferative assays, where peripheral blood mononuclear cells (10^5) were cultured with peptides as indicated for 7 days in triplicates before harvesting. To measure the proliferative capacity of the cultures, ^{3}H-thymidine ($3,7x10^4$ Bq/ well) was added to the culture overnight before harvesting. Values are given as mean counts per minute (cpm) of the triplicates.

Figures 3 and 4

Figures 3 and 4 (Fig. 3 and Fig. 4) show the reactivity of tumor infiltrating lymphocytes (TILs) obtained from a patient with advanced pancreatic cancer. The T cells were obtained from a tumor biopsy and was successfully propagated *in vitro* to establish a T cell line. The T cell line was CD3+, CD4+ and CD8-, and proliferated specificially in response to the telomerase peptides. The results in Fig. 3 show T cells that recognise the peptides with seq. id. no. 2 and 3 when compared to controls with medium alone. The results in Fig. 4 show T cells that recognise the peptide with seq. id. no. 2. The TILs were expanded by co-cultureing with recombinant human interleukin 2 (rIL-2) and tested after 14 days in standard proliferation assay using peptides with sequence id. nos. 2, 3, 4 and 7.

Table 1

LMSVYVVEL	FLHWLMSVYVVELLRSFFYVTE
ELLRSFFYV	EARPALLTSRLRFIPK
YVVELLRSF	DGLRPIVNMDYVVGAR
VVELLRSFF	GVPEYGCVVNLRKVVNF
SVYVVELLR	
VELLRSFFY	
YVTETTFQK	
RLFFYRKSV	
SIGIRQHLK	
RPALLTSRL	
ALLTSRLRF	
LLTSRLRFI	
RPIVNMDYV	
LRPIVNMDY	
YVVGARTFR	
VVGARTFRR	
GARTFRREK	
ARTFRREKP	
PPELYFVKV	
ELYFVKVDV	
FVKVDVTGA	
IPQDRLTEV	
DRLTEVIAS	
RLTEVIASI	
IPQGSILSTL	
ILSTLLCSL	
LLRLVDDFL	
RLVDDFLLV	
VPEYGCVVN	
VPEYGCVVNL	
TLVRGVPEY	
FLRTLVRGV	
GVPEYGCVV	
VVNLRKTVV	
GLFPWCGLL	

Table 2

YAETKHFLY
ISDTASLCY
DTDPRRLVQ
AQDPPPELY
LTDLQPYMR
QSDYSSYAR

ILAKFLHWL
ELLRSFFYV
LLARCALFV
WLCHQAFLL
RLVDDFLLV
RLFFYRKSV
LQLPFHQQV
RLGPQGWRL
SLQELTWKM
NVLAFGFAL
VLLKTHCPL
FLLVTPHLT
TLTDLQPYM
RLTEVIASI
FLDLQVNSL
SLNEASSGL
ILSTLLCSL
LLGASVLGL
VLAFGFALL
LQPYMRQFV
LMSVYVVEL
RLPQRYWQM
RQHSSPWQV
YLPNTVTDA
NMRRKLFGV
RLTSRVKAL
LLQAYRFHA
LLDTRTLEV
YMRQFVAHL
LLTSRLRFI
CLVCVPWDA
LLSSLRPSL

Table 2 (Continued)

FMCHHAVRI
LQVNSLQTV
LVAQCLVCV
CLKELVARV
FLRNTKKFI
ALPSDFKTI
VLVHLLARC
VQSDYSSYA
SVWSKLQSI
KLPGTTLTA
QLSRKLPGT
ELYFVKVDV
GLLLDTRTL
WMPGTPRRL
SLTGARRLV
VVIEQSSSL
LPSEAVQWL
QAYRFHACV

GLFDVFLRF
KLFGVLRLK
RLREEILAK
TLVRGVPEY
GLPAPGARR
GLFPWCGLL
KLTRHRVTY
VLPLATFVR
ELVARVLQR

DPRRLVQLL
FVRACLRRL
SVREAGVPL
AGRNMRRKL
LARCALFVL
RPAEEATSL
LPSDFKTIL
LPSEAVQWL
LPGTTLTAL
RPSFLLSSL
LPNTVTDAL
RPALLTSRL

Table 2 (Continued)

RCRAVRSLL
MPRAPRCRA

GIRRDGLLL
VLRLKCHSL
YMRQFVAHL
SLRTAQTQL
QMRPLFLEL
LLRLVDDFL
FVQMPAHGL
HASGPRRRL
VVIEQSSSL
RVISDTASL
CVPAAEHRL
RVKALFSVL
NVLAFGFAL
LVARVLQRL
FAGIRRDGL
HAQCPYGVL
RAQDPPPEL
AYRFHACVL
HAKLSLQEL
GAKGAAGPL
TASLCYSIL
APRCRAVRS
GARRLVETI
AQCPYGVLL
HAKTFLRTL
EATSLEGAL
KAKNAGMSL
AQTQLSRKL
AGIRRDGLL

VLRLKCHSL
ILKAKNAGM
DPRRLVQLL
GAKGAAGPL
FAGIRRDGL
GARRRGGSA
HAKTFLRTL
HAKLSLQEL

Table 2 (Continued)

LARCALFVL
EHRLREEIL
NMRRKLFGV

CAREKPQGS
LTRHRVTYV

RRFLRNTKK
RRDGLLLRL
RREKRAERL
RRLVETIFL
LRFMCHHAV
RRYAVVQKA
KRAERLTSR
RRKLFGVLR
RRRGGSASR
RRLPRLPQR
RRLGPQGWR
LRGSGAWGL
HREARPALL
VRRYAVVQK
ARTSIRASL
HRVTYVPLL
LRSHYREVL
MRPLFLELL
HRAWRTFVL
MRRKLFGVL
LRLVDDFLL
LRRVGDDVL
YRKSVWSKL
QRLCERGAK
FRALVAQCL
SRKLPGTTL
LRRLVPPGL
RRSPGVGCV
RRVGDDVLV
VRGCAWLRR
VRSLLRSHY
ARTFRREKR
SRSLPLPKR
IRASLTFNR

Table 2 (Continued)

LREEILAKF
IRRDGLLLR
QRGDPAAFR
LRPIVNMDY

ARRLVETIF
ARPALLTSR
LRPSLTGAR
LRLKCHSLF
FRREKRAER
ARGGPPEAF
CRAVRSLLR
GRTRGPSDR
RRRLGCERA
LRELSEAEV
ARCALFVLV

RPAEEATSL
DPRRLVQLL
RPSFLLSSL
LPSEAVQWL
RPALLTSRL
LPSDFKTIL
RPPPAAPSF
LPRLPQRYW
LPNTVTDAL
LPGTTLTAL
LAKFLHWLM
KAKNAGMSL
GSRHNERRF
KALFSVLNY
SPLRDAVVI
RAQDPPPEL
MPAHGLFPW

AEVRQHREA
REAGVPLGL
EEATSLEGA
LEAAANPAL
QETSPLRDA
REVLPLATF

Table 2 (Continued)

KEQLRPSFL
REKPQGSVA
LEVQSDYSS
REARPALLT
EEDTDPRRL
REEILAKFL
CERGAKNVL
DDVLVHLLA
GDMENKLFA
YERARRPGL

CLAIMS

1. A telomerase protein or peptide for use in a method of treatment or prophylaxis of cancer.

2. A telomerase protein or peptide as claimed in Claim 1 for a use as specified therein, the telomerase protein or peptide being capable of generating a T cell response directed against the telomerase protein.

3. A telomerase protein or peptide as claimed in Claim 1 or 2 for a use as specified therein, in which the method comprises administering to a mammal suffering or likely to suffer from cancer a therapeutically effective amount of the telomerase protein or peptide so that a T cell response against the telomerase is induced in the mammal.

4. A telomerase protein or peptide as claimed in Claim 2 or 3 for a use as specified therein, in which the T cell response induced is a cytotoxic T cell response.

5. A telomerase protein or peptide as claimed in any of the preceding claims for a use as specified therein, in which the telomerase protein or peptide is a human telomerase protein or peptide.

6. A telomerase peptide as claimed in any of the preceding claims for a use as specified therein, in which the telomerase peptide has a length of between 8 and 25 amino acids.

7. A telomerase peptide as claimed in Claim 6 for a use as specified therein, in which the peptide has a length of 9, 12, 13, 16 or 21 amino acids.

8. A telomerase peptide as claimed in any of Claims 1 to 5 for a use as specified therein, in which the peptide has a length of at least 9 amino acids.

9. A telomerase peptide as claimed in any of the preceding claims for a use as specified therein, in which the telomerase peptide has an amino acid sequence which partially or totally overlaps a sequence selected from any of the following sequences: LLRSFFYVTE, SRLRFIPK, LRPIVNMDYVVG, PELYFVKVDVTGAYDTI, KSYVQCQGIPQGSILSTLLCSLCY, LLLRLVDDFLLVT, GCVVNLRKTVV,
WLMSVYVVELLRSFFYVTETTFQKNRLFFYRKSVWSKLQSIGIRQHLK,
EVRQHREARPALLTSRLRFIPKPDG, LRPIVNMDYVVGARTFRREKRAERLTSRV,
PPPELYFVKVDVTGAYDTIPQDRLTEVIASIIKP,
KSYVQCQGIPQGSILSTLLCSLCYGDMENKLFAGI, LLRLVDDFLLVTPHLTH,
AKTFLRTLVRGVPEYGCVVNLRKTVV and HGLFPWCGLLL.

10. A telomerase peptide as claimed in any of the preceding claims for a use as specified therein, in which the telomerase peptide has an amino acid sequence: LMSVYVVEL, ELLRSFFYV, YVVELLRSF, VVELLRSFF, SVYVVELLR, VELLRSFFY, YVTETTFQK, RLFFYRKSV, SIGIRQHLK, RPALLTSRL, ALLTSRLRF, LLTSRLRFI, RPIVNMDYV, LRPIVNMDY, YVVGARTFR, VVGARTFRR, GARTFRREK, ARTFRREKP, PPELYFVKV, ELYFVKVDV, FVKVDVTGA, IPQDRLTEV, DRLTEVIAS, RLTEVIASI, IPQGSILSTL, ILSTLLCSL, LLRLVDDFL, RLVDDFLLV, VPEYGCVVN, VPEYGCVVNL, TLVRGVPEY, FLRTLVRGV, GVPEYGCVV, VVNLRKTVV or GLFPWCGLL.

11. A telomerase peptide as claimed in any of the preceding claims for a use as specified therein, in which the telomerase peptide has an amino acid sequence: FLHWLMSVYVVELLRSFFYVTE, EARPALLTSRLRFIPK, DGLRPIVNMDYVVGAR or GVPEYGCVVNLRKVVNF, i.e. seq. id no. 1, 2, 3 or 4 respectively.

12. A telomerase peptide as claimed in any of the preceding claims for a use as specified therein, in which the telomerase peptide has an amino acid sequence: YAETKHFLY, ISDTASLCY, DTDPRRLVQ, AQDPPPELY, LTDLQPYMR, QSDYSSYAR, ILAKFLHWL, ELLRSFFYV, LLARCALFV, WLCHQAFLL, RLVDDFLLV, RLFFYRKSV, LQLPFHQQV, RLGPQGWRL, SLQELTWKM, NVLAFGFAL, VLLKTHCPL, FLLVTPHLT, TLTDLQPYM, RLTEVIASI, FLDLQVNSL, SLNEASSGL, ILSTLLCSL, LLGASVLGL, VLAFGFALL, LQPYMRQFV, LMSVYVVEL, RLPQRYWQM, RQHSSPWQV, YLPNTVTDA, NMRRKLFGV, RLTSRVKAL, LLQAYRFHA, LLDTRTLEV, YMRQFVAHL, LLTSRLRFI, CLVCVPWDA, LLSSLRPSL, FMCHHAVRI, LQVNSLQTV, LVAQCLVCV, CLKELVARV, FLRNTKKFI, ALPSDFKTI, VLVHLLARC, VQSDYSSYA, SVWSKLQSI, KLPGTTLTA, QLSRKLPGT, ELYFVKVDV, GLLLDTRTL, WMPGTPRRL, SLTGARRLV, VVIEQSSSL, LPSEAVQWL, QAYRFHACV, GLFDVFLRF, KLFGVLRLK, RLREEILAK, TLVRGVPEY, GLPAPGARR, GLFPWCGLL, KLTRHRVTY, VLPLATFVR, ELVARVLQR, DPRRLVQLL, FVRACLRRL, SVREAGVPL, AGRNMRRKL, LARCALFVL, RPAEEATSL, LPSDFKTIL, LPSEAVQWL, LPGTTLTAL, RPSFLLSSL, LPNTVTDAL, RPALLTSRL, RCRAVRSLL, MPRAPRCRA, GIRRDGLLL, VLRLKCHSL, YMRQFVAHL, SLRTAQTQL, QMRPLFLEL, LLRLVDDFL, FVQMPAHGL, HASGPRRRL, VVIEQSSSL, RVISDTASL, CVPAAEHRL, RVKALFSVL, NVLAFGFAL, LVARVLQRL, FAGIRRDGL, HAQCPYGVL, RAQDPPPEL, AYRFHACVL, HAKLSLQEL, GAKGAAGPL, TASLCYSIL, APRCRAVRS, GARRLVETI, AQCPYGVLL, HAKTFLRTL, EATSLEGAL, KAKNAGMSL, AQTQLSRKL, AGIRRDGLL, VLRLKCHSL, ILKAKNAGM, DPRRLVQLL, GAKGAAGPL, FAGIRRDGL, GARRRGGSA, HAKTFLRTL, HAKLSLQEL, LARCALFVL, EHRLREEIL, NMRRKLFGV, CAREKPQGS, LTRHRVTYV, RRFLRNTKK, RRDGLLLRL, RREKRAERL, RRLVETIFL, LRFMCHHAV, RRYAVVQKA, KRAERLTSR, RRKLFGVLR, RRRGGSASR, RRLPRLPQR, RRLGPQGWR, LRGSGAWGL, HREARPALL, VRRYAVVQK, ARTSIRASL, HRVTYVPLL, LRSHYREVL, MRPLFLELL, HRAWRTFVL, MRRKLFGVL, LRLVDDFLL, LRRVGDDVL, YRKSVWSKL, QRLCERGAK, FRALVAQCL, SRKLPGTTL, LRRLVPPGL, RRSPGVGCV, RRVGDDVLV, VRGCAWLRR, VRSLLRSHY, ARTFRREKR, SRSLPLPKR, IRASLTFNR, LREEILAKF, IRRDGLLLR, QRGDPAAFR, LRPIVNMDY, ARRLVETIF, ARPALLTSR, LRPSLTGAR, LRLKCHSLF, FRREKRAER, ARGGPPEAF, CRAVRSLLR, GRTRGPSDR, RRRLGCERA, LRELSEAEV, ARCALFVLV, RPAEEATSL,

DPRRLVQLL, RPSFLLSSL, LPSEAVQWL, RPALLTSRL, LPSDFKTIL, RPPPAAPSF, LPRLPQRYW, LPNTVTDAL, LPGTTLTAL, LAKFLHWLM, KAKNAGMSL, GSRHNERRF, KALFSVLNY, SPLRDAVVI, RAQDPPPEL, MPAHGLFPW, AEVRQHREA, REAGVPLGL, EEATSLEGA, LEAAANPAL, QETSPLRDA, REVLPLATF, KEQLRPSFL, REKPQGSVA, LEVQSDYSS, REARPALLT, EEDTDPRRL, REEILAKFL, CERGAKNVL, DDVLVHLLA, GDMENKLFA or YERARRPGL.

13. A nucleic acid for use in a method of treatment or prophylaxis of cancer, the nucleic acid being capable of encoding a telomerase protein or peptide as claimed in any of the preceding claims.

14. A pharmaceutical composition comprising at least one telomerase protein or peptide as claimed in any of Claims 1 to 12, or at least one nucleic acid as claimed in Claim 13, together with a pharmaceutically acceptable carrier or diluent.

15. A pharmaceutical composition comprising a combination of at least one telomerase protein or peptide as claimed in any of Claims 1 to 12 and at least one peptide capable of inducing a T cell response against an oncogene or mutant tumour suppressor protein or peptide, together with a pharmaceutically acceptable carrier or diluent.

16. A pharmaceutical composition as claimed in Claim 14 or 15 for use in the treatment or prophylaxis of any of the following cancers: breast cancer, prostate cancer, pancreatic cancer, colo-rectal cancer, lung cancer, malignant melanoma, leukaemias, lymphomas, ovarian cancer, cervical cancer and biliary tract carcinomas.

17. A method for the preparation of a pharmaceutical composition as claimed in Claim 14, in which the method comprises mixing at least one telomerase protein or peptide as claimed in any of Claims 1 to 12, or at least one nucleic acid as claimed in Claim 13, with a pharmaceutically acceptable carrier or diluent.

18. A method for the preparation of a pharmaceutical composition as claimed in Claim 15, in which the method comprises mixing at least one telomerase protein or peptide as claimed in any of Claims 1 to 12, with at least one peptide capable of inducing a T cell response against an oncogene or mutant tumour suppressor protein or peptide, and a pharmaceutically acceptable carrier or diluent.

19. A pharmaceutical composition as claimed in Claim 15 or a method of making a pharmaceutical composition as claimed in Claim 18, in which the oncogene protein or peptide is a mutant p21-*ras* protein or peptide.

20. A pharmaceutical composition as claimed in claimed in Claim 15 or a method of making a pharmaceutical composition as claimed in Claim 18, in which the tumour suppressor protein or peptide is a retinoblastoma or p53 protein or peptide.

21. The use, in the preparation of a medicament for the treatment or prophylaxis of cancer, of a telomerase protein or peptide, or a nucleic acid capable of encoding a telomerase protein or peptide.

22. A method of generating T lymphocytes capable of recognising and destroying tumour cells in a mammal, in which the method comprises taking a sample of T lymphocytes from a mammal, and culturing the T lymphocyte sample in the presence of telomerase protein or peptide in an amount sufficient to generate telomerase T lymphocytes.

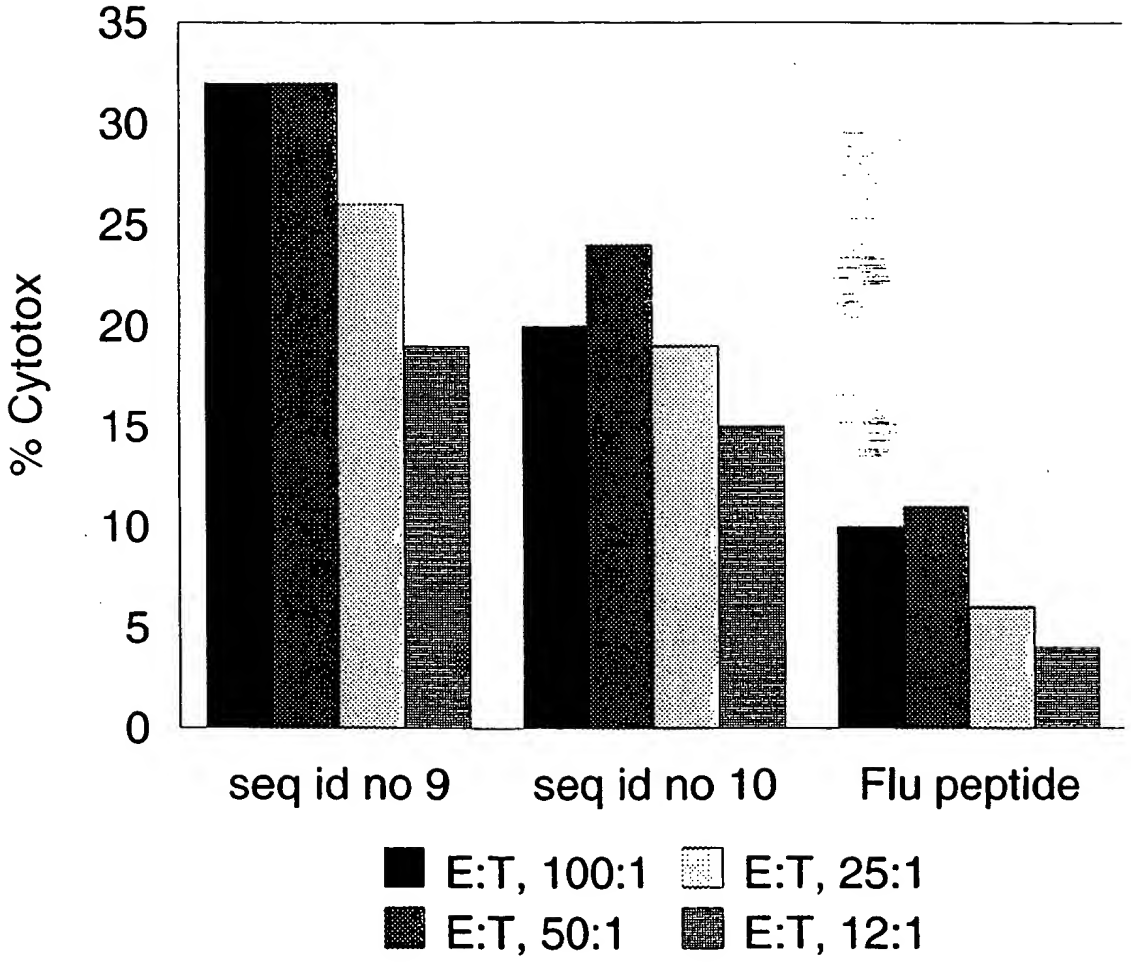
23. A telomerase protein or peptide for use in a method of treatment or prophylaxis of cancer substantially as hereinbefore described with reference to and as shown in the drawing.

24. The use, in the preparation of a medicament for the treatment or prophylaxis of cancer, of a telomerase protein or peptide, or a nucleic acid capable of encoding a telomerase protein or peptide, substantially as hereinbefore described with reference to and as shown in the drawing.

25. A nucleic acid capable of encoding a telomerase protein or peptide for use in a method of treatment or prophylaxis of cancer substantially as hereinbefore described with reference to and as shown in the drawing.

26. A pharmaceutical composition or a method of preparation of such a pharmaceutical composition comprising at least one telomerase protein or peptide substantially as hereinbefore described with reference to and as shown in the drawing.

27. A method of generating telomerase T lymphocytes
bstantially as hereinbefore described.


35
30
25
20
15
10
5
0
% Cytotox
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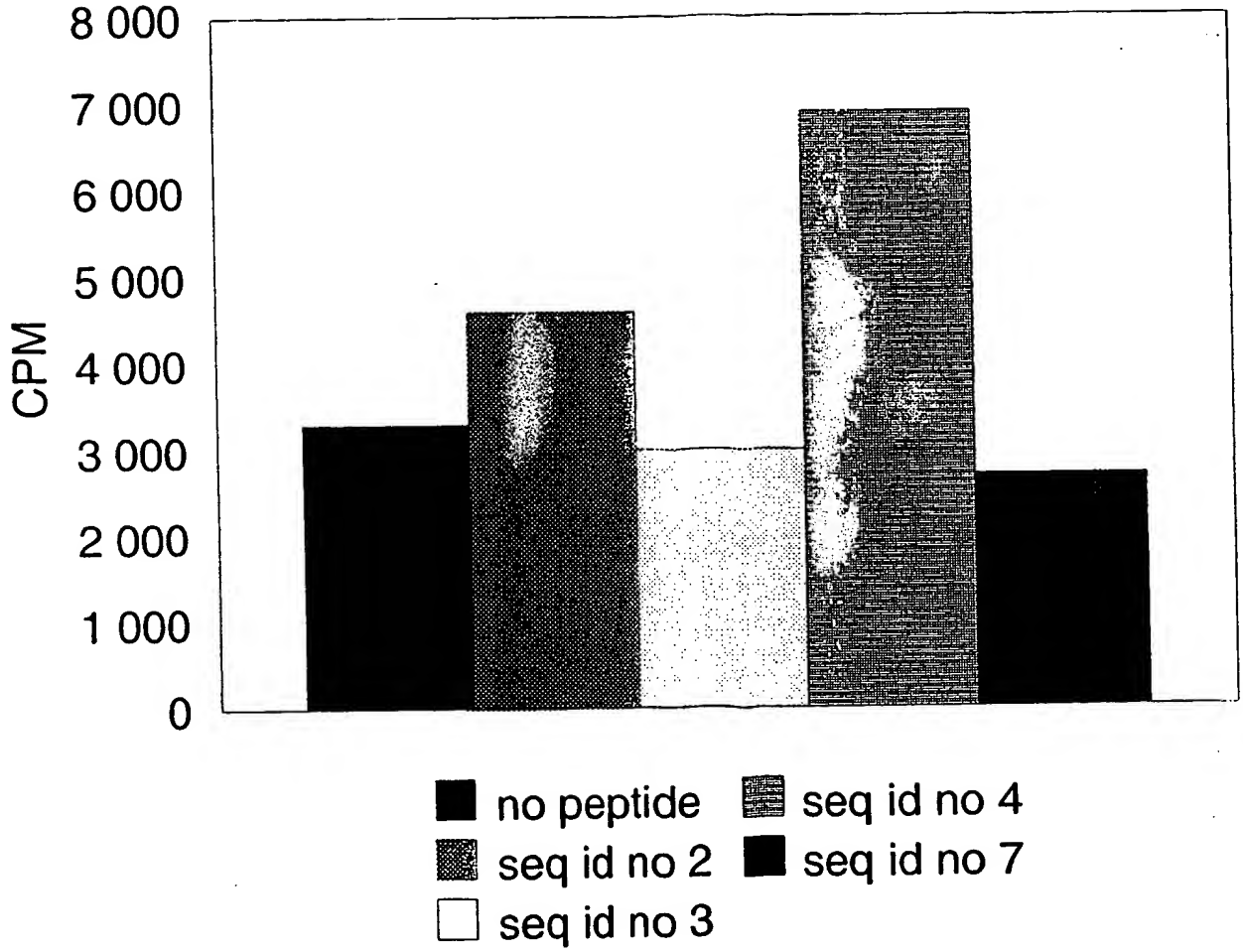
seq id no 10
Flu peptide
E:T, 100:1
E:T, 25:1
E:T, 50:1
E:T, 12:1

Fig. 1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7 000
6 000
5 000
4 000
3 000
2 000
1 000
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CPM
no peptide
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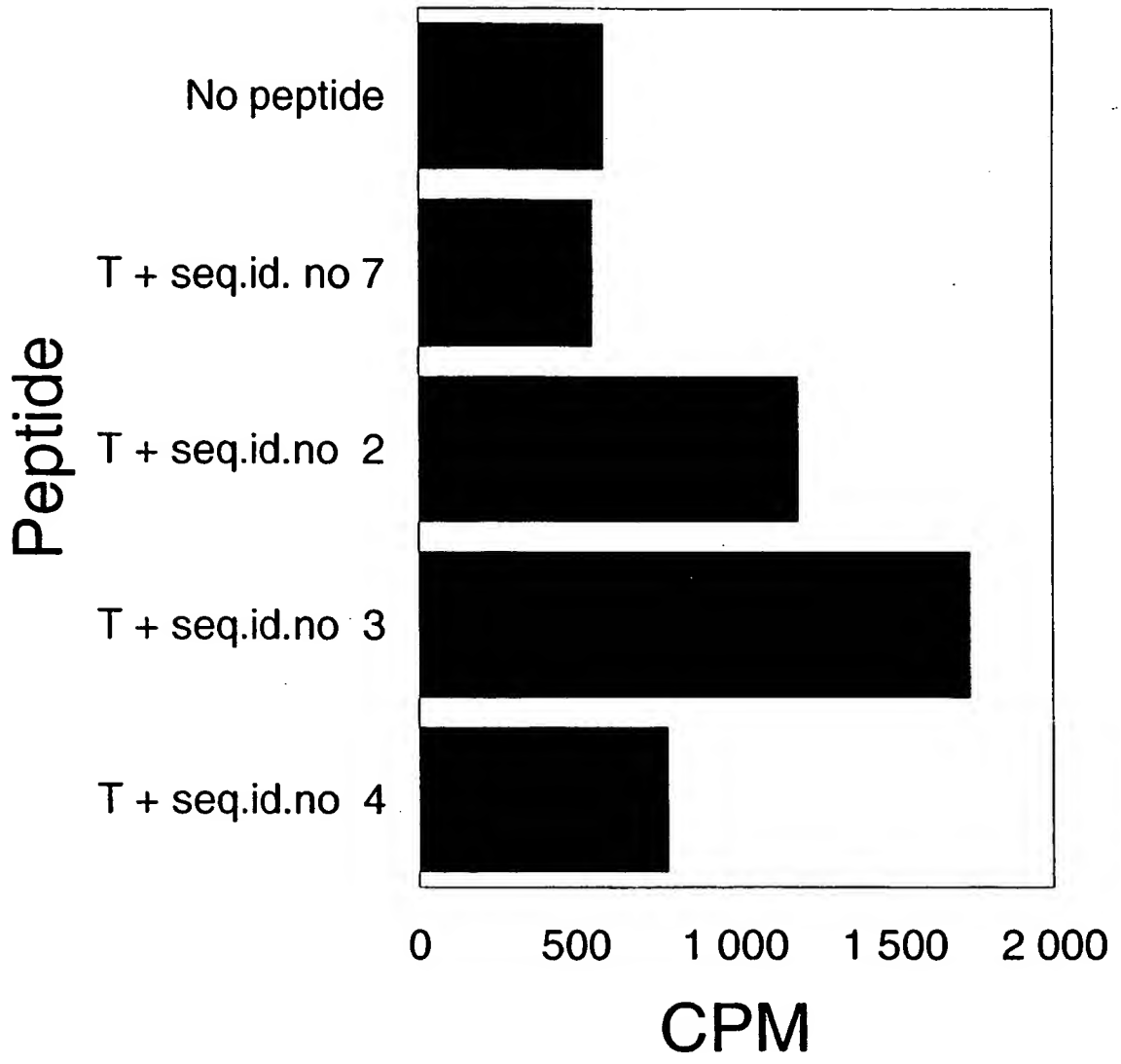
seq id no 7
seq id no 3

Fig. 2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T + seq.id.no 2
T + seq.id.no 3
T + seq.id.no 4
Peptide
0
500
1 000
1 500
2 000
CPM

Fig. 3

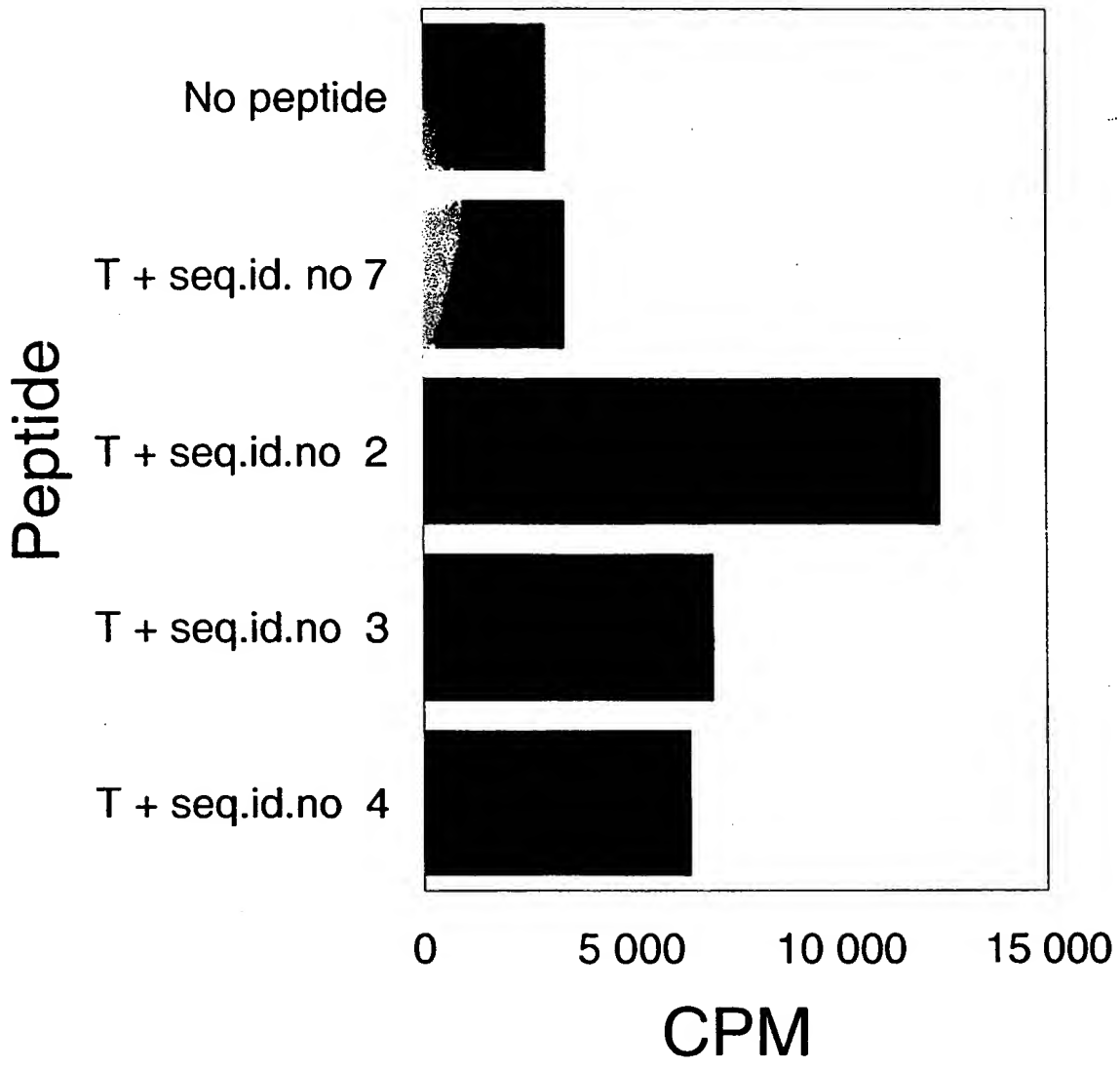
No peptide
T + seq.id. no 7
T + seq.id.no 2
T + seq.id.no 3
T + seq.id.no 4
Peptide
0
5 000
10 000
15 000
CPM

Fig. 4

Sequence Identity List

SEQUENCE LISTING

COMMON FOR ALL SEQUENCES.

SEQUENCE TYPE: Peptide

SEQUENCE UNIT: Amino Acid

TOPOLOGY: Linear

SEQUENCE ID NO: 1

SEQUENCE LENGTH: 22 amino acids

F L H W L M S V Y V V E L L R S F F Y V T E

1 5 10 15 20

SEQUENCE ID NO: 2

SEQUENCE LENGTH: 16 amino acids

E A R P A L L T S R L R F I P K

1 5 10 15

SEQUENCE ID NO: 3

SEQUENCE LENGTH: 16 amino acids

D G L R P I V N M D Y V V G A R

1 5 10 15

SEQUENCE ID NO: 4

SEQUENCE LENGTH: 18 amino acids

G V P E Y G C V V N L R K T V V N F

1 5 10 15

SEQUENCE ID NO: 5

SEQUENCE LENGTH: 23 amino acids

K F L H W L M S V Y V V E L L R S F F Y V T E

1 5 10 15 20

SEQUENCE ID NO: 6

SEQUENCE LENGTH: 17 amino acids

K F L H W L M S V Y V V E L L R S

1 5 10 15

SEQUENCE ID NO: 7

SEQUENCE LENGTH: 18 amino acids

L M S V Y V V E L L R S F F Y V T E

1 5 10 15

SEQUENCE ID NO: 9

SEQUENCE LENGTH: 9 amino acids

I L A K F L H W L

1 5

SEQUENCE ID NO: 10

SEQUENCE LENGTH: 9 amino acids

E L L R S F F Y V

1 5

SEQUENCE ID NO: 11

SEQUENCE LENGTH: 9 amino acids

L M S V Y V V E L

1 5

SEQUENCE ID NO: 12

SEQUENCE LENGTH: 9 amino acids

T S R L R F I P K

1 5

SEQUENCE ID NO: 13

SEQUENCE LENGTH: 9 amino acids

L T S R L R F I P

1 5

SEQUENCE ID NO: 14

SEQUENCE LENGTH: 9 amino acids

L L T S R L R F I

1 5

SEQUENCE ID NO: 15

SEQUENCE LENGTH: 9 amino acids

A L L T S R L R F

1 5

SEQUENCE ID NO: 16

SEQUENCE LENGTH: 9 amino acids

P A L L T S R L R

1 5

SEQUENCE ID NO: 17

SEQUENCE LENGTH: 9 amino acids

R P A L L T S R L

1 5

SEQUENCE ID NO: 18

SEQUENCE LENGTH: 9 amino acids

A R P A L L T S R

1 5

SEQUENCE ID NO: 19

SEQUENCE LENGTH: 9 amino acids

E A R P A L L T S

1 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 99/00220

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A61K 38/45, C12N 9/12, A61K 39/39, C12N 5/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A61K, C12N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	Immunity, Volume 10, June 1999, Robert H. Vonderheide et al, "The Telomerase Catalytic Subunit Is a Widely Expressed Tumor-Associated Antigen Recognized by Cytotoxic T Lymphocytes" page 673 - page 679	1-27
	--	
X	WO 9814593 A2 (GERON CORPORATION ET AL), 9 April 1998 (09.04.98), page 100, line 18 - line 29, example 8	1-27
	--	
A	WO 9214756 A1 (NORSK HYDRO A.S.), 3 Sept 1992 (03.09.92)	15-16,18-20
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 December 1999	12 -12- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Carolina Palmcrantz/ELY Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 99/00220

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9735619 A1 (GENITRIX, L.L.C.), 2 October 1997 (02.10.97), page 1, line 10 - line 14; page 1, line 23 - line 24; page 25, line 21, claim 1	1-14,16-17, 21,23-26
	--	
X	WO 9801542 A1 (THE REGENTS OF THE UNIVERSITY OF CALIFORNIA), 15 January 1998 (15.01.98), page 2, line 18 - line 21; page 2, line 29 - line 31; page 4, line 12 - line 15, page 5, line 18 - line 20	1-14,16-17, 21,23-26
	--	
E,X	WO 9950386 A2 (GERON CORPORATION), 7 October 1999 (07.10.99), claim 17	1-9,14, 16-17,21, 23-24,26
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO99/00220

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 23-27
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

See extra sheet.*

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.**

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 1-8, 9(partly, the first a.a. sequence), 10 (partly, the last five a.a. sequences), 11, 12(partly, the first twenty-one a.a. sequences), 13-27

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

* The wording "...substantially as hereinbefore described with reference to and as shown in the drawing..." of claims 23-26 is not considered to define the intended telomerase protein or peptide in a clear and concise manner (c.f. PCT, Article 6). Therefore, the search has been performed as if the telomerase protein or peptide had been defined as in claims 1-8 and the parts of claims 9-12 that have been searched.

Further, the wording "...substantially as hereinbefore described." of claim 27 is not considered to define the intended method in a clear and concise manner (PCT, Article 6). Therefore, the search has been performed based on the method defined in claim 22.

** As is stated in Annex B to Administrative Instructions under the PCT, in force July 1, 1992 (PCT GAZETTE 1992, June 25, pages 7062-9, see page 7063 and example 5) unity of invention exists only when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding "special technical features"-i.e. features that define a contribution which each of the inventions makes over the prior art (c.f. PCT Rule 13.2).

Initially, all the subject matters were included in the search, however it soon became obvious that pertinent prior art exists making it necessary to reconsider the technical relationship between the different solutions revealed in the claims.
This prior art is represented by WO 9814593. The document discloses that immunogenic peptides or polypeptides having a human telomerase reverse transcriptase (hTRT) sequence can be used to elicit an anti-hTRT immune response in a patient, i.e. act as a vaccine. An immune response can also be raised by delivery of plasmid vectors encoding the polypeptide of interest. Once immunized, the individual or animal will elicit a heightened immune response against cells expressing high levels of telomerase, e.g. malignt cells (see page 100, lines 19-29 in WO 9814593).

A search for a strict new common concept of invention has failed and many of the claims represent subject matter forming lack of unity with each other.

The International Searching Authority (ISA) has arrived at the following principle of division:

.../...

Main invention 1, claims 1-14, 16 (partly), 17, 21, 23-26, concerns a pharmaceutical comprising a telomerase protein or polypeptide, or a nucleic acid encoding a telomerase protein or peptide, for the treatment or prophylaxis of cancer.
Further, since immunogenic peptides derived from the human telomerase sequence are known in the prior art, no unifying special technical feature seems to be present between the 257 different amino acid sequences given in claims 9, 10, 11 and 12 Therefore, every one of these sequences (peptides) can be considered to constitute a separate invention.

Invention 2, claims 15, 16 (partly), 18-20, concerns a pharmaceutical composition comprising a combination of a telomerase protein or peptide and a peptide capable of inducing a T cell response against an oncogene or mutant tumour suppressor protein or peptide.

Invention 3, claims 22, 27, concerns a method of generating T lymphocytes. The method comprises taking a sample of T lymphocytes from a mammal, and culturing the T lymphocyte sample in the presence of a telomerase protein or peptide.

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/11/99

International application No.
PCT/NO 99/00220

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9814593 A2	09/04/98	AU 4803697 A	24/04/98
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		US 5770422 A	23/06/98
		US 5917025 A	29/06/99
WO 9950386 A2	07/10/99	NONE	